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Cardiac rehabilitation: health characteristics and socio-economic status among those who do not attend

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Background: Cardiac rehabilitation (CR) is well documented, in randomised trials, to reduce mortality risk after myocardial infarction (MI). Selection of healthy patients for CR is a relatively unexplored problem. Our aims were to identify predictors of CR-attendance and to describe the prognosis as concerns mortality, re-admission and invasive treatment among CR-attendees as compared to CR-non-attendees. **Methods**: From a cohort of 138 290 persons aged 30–69 years, we identified consecutive MI patients, between 1 April 2000 and 31 March 2002. There were 206 MI patients, who survived until admission, and among the 200 who survived 30 days, 145 (72.5%) attended a comprehensive CR programme. Data were obtained from patient charts and from Danish population registers, and as a result we had no non-participation for the study. **Results:** The 2-year mortality proportions for patients surviving the first 30 days of admission were 2.8 and 21.8% among CR-attendees and CR-non-attendees, respectively ($P < 0.0001$). Among CR-non-attendees, there was a smaller fraction having an invasive treatment performed as compared with CR-attendees. By multiple logistic regression controlling for age and sex, CR-attendance was associated with chest pain, whereas CR-non-attendance was associated with low gross income, single living and inverted T-wave in the electrocardiogram. **Conclusion:** CR attendance rate was 72.5%. Non-attendees have a higher mortality risk, which in part may be attributed to selection of healthy patients. Non-attendees are older and more likely to have atypical symptoms at admission, a low socioeconomic status and to live alone. Special attention is needed to improve CR attendance among such patients.

Keywords: cohort study, myocardial infarction, rehabilitation, socioeconomic factors

Introduction

Coronary artery disease is a major health problem in virtually all countries of the world with no signs of decrease in incidence of the acute manifestation i.e. acute coronary syndrome.[1]

Systematic reviews[2,3] of randomised controlled trials show that cardiac rehabilitation (CR) is effective in reducing mortality risk after myocardial infarction (MI). Patients in an every day clinical setting, who attend CR, may also have a lower mortality, which partly may be attributed to selection of healthy patients for CR. In observational studies, the reported attendance-rate for CR is often less than 50%.[4] The problem is apparent especially among older women,[4,5] among those with several risk factors,[6] low socioeconomic status[6–9] and low social support.[9,10] It is now important to ensure that those patients who do not attend CR are characterised and efforts made to include them in CR programmes.[11,12] This study is performed in a modern comprehensive rehabilitation setting with an uptake of more than 70%.

Recommendations of components to include in a comprehensive CR programme are described in detail in the recent statement from the American Heart Association,[13] concerning risk factor modification and psychosocial intervention. Among patients with MI, the effect of lipid lowering therapy, treatment with anti-platelet drugs, beta-blockers and angiotension-converting enzyme-inhibitors is well documented to reduce mortality.[14] Smoking cessation,[15] intensive blood-glucose control in diabetic patients,[16,17] and blood pressure reduction in hypertensive patients[18] also improve prognosis. Although the secondary preventive treatment goals have been described in detail,[19] they are difficult to achieve.[20,21]

The aims of our study were (i) to identify predictors of CR-attendance and (ii) to describe the prognosis as concerns re-admissions for MI, percutaneous coronary intervention (PCI), coronary artery bypass grafting (CABG), and mortality among CR-attendees as compared to CR-non-attendees.

Methods

Design and patients

This design was a cohort study. The cohort consisted of all persons aged 30–69 years residing in the Municipality of Aarhus, Denmark, as of 1 April 2001 (i.e. the mid-point population) in total 138 290 persons, who were followed as concerns admissions for MI during 1 April 2000–31 March 2002 as earlier described.[22] We identified 962 consecutive patients surviving till admission to the non-invasive coronary care unit at Aarhus Sygehus, serving the municipality. There were 206 patients with incident (first episode) of MI and they were followed as concerns mortality during two years of the initial admission and as concerns re-admissions for MI, PCI and CABG during one year.

The non-invasive unit are specialised in CR, and all MI patients admitted to this unit are offered to attend CR. Patients needing PCI and CABG are transferred quickly to an invasive unit.

Of the 200 patients with MI who survived for at least 30 days, 72.5% attended CR.

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Case-finding

Patients, surviving until admission with possible MI were identified from the coronary care unit at Aarhus Sygehus, based on daily visits in the unit by one of the members of the research team. All patients belonging to the cohort and admitted alive to the coronary care unit, irrespective of the admission diagnosis, were screened for possible MI. A screening paper was filled in based on symptoms, history of MI, 12-lead electrocardiogram (ECG) and markers of myocardial necrosis (MMN). The diagnosis was evaluated within 72 h of admission. A final diagnosis of MI was assigned if there was MI according to international criteria.[23]

Clinical data

Information concerning clinical parameters was obtained from the patients' charts as were the 12-lead ECG. Serial measurements of MMN, either troponin T or Creatine Kinase MB were obtained from the hospital laboratory database. Details of re-admissions, PCI and CABG were obtained from patients' charts and from the online hospital register, which covers all admissions to hospitals in Denmark. If patients had been admitted from outside the Municipality of Aarhus, the patient chart was obtained.

Socio-demographic data

Linked data on age, sex, marital status, citizenship, number of adults and of children in the household and death was obtained from the Central Office of Civil Registration. From Statistics Denmark we received information concerning the individual's family type, education, gross income, socio-economic status and immigration status. There was no missing information in any of these data sets.

Comprehensive cardiac rehabilitation programme at Aarhus Sygehus

The comprehensive CR programme is divided into three phases: (i) *the acute phase* during the initial admission, where all patients as part of the standard treatment are offered and motivated to attend CR, and (ii) *the rehabilitation phase*, at an outpatient clinic, starting at the latest 1–2 weeks after submission. Four individual consultations are offered, two of them with a physician, and they focus on needs of invasive and medical treatment. Laboratory testing concerning plasma lipids, blood glucose, blood pressure and chest-X-ray as well as an exercise test is performed. Training concerning smoking cessation, dietary instruction (spouse is also invited), and 6 weeks of twice-a-week exercise are offered. In this phase, a cross-functional team takes care of patient education, life style changes, exercise and psychosocial factors. Finally (iii) *the follow-up phase*, in which the general practitioner is involved in the continuous motivation and control of the patient to achieve the individualised treatment targets.

Statistical analysis

Readmissions for MI, invasive treatments with PCI or CABG, and attendance in CR were the dependent variables. The statistical analysis included Pearson's χ^2 test or Fisher's exact test for the 2×2 table and multiple logistic regression. Regression models were reduced by forwards selection of variables using the χ^2 distributed *–2* ln (*likelihood ratio*) and the Wald χ^2 as significance tests. Regression model goodness of fit was estimated by use of the Hosmer–Lemeshow test. $P < 0.05$ was applied as the general level of significance. The log rank test was used to test the difference in survival between groups, as illustrated by Kaplan Meier Survival plots.

Ethics

The regional Committee of Ethics in Medical Science and the Danish Data Protection Agency approved the study and its database.

Results

Among 206 consecutive MI patients, 17 (8.3%) had died within one year of admission. The one-year mortality proportion, among patients who survived 30 days after admission, was 14.5% among CR-non-attendees as compared with 2.1% among CR-attendees ($P < 0.001$). After two years, the mortality proportion was 21.8 and 2.8% among CR-non-attendees and CR-attendees, respectively ($P < 0.0001$) (table 1, Figure 1). Among CR-non-attendees fewer had a PCI performed within one year after admission ($P = 0.004$) than had CR-attendees, whereas there was no significant difference in the fractions being re-admitted with MI (table 1).

By bivariate analysis controlling for age, a positive association with CR-attendance was found among patients, who were employees (upper level), who had chest pain at admission, who had an elevated level of LDL-cholesterol or who had been treated with aspirin or beta-blocker. A negative association was found among patients with foreign citizenship, who lived alone, who had a gross yearly income below DKK 100 000, who were not actively employed or who had T-wave inversion or tachycardia in the ECG (table 2).

Two out of three patients at admission had signs of the metabolic syndrome i.e. either abdominal obesity, dyslipidemia or glucose intolerance.

By multiple logistic regression (table 3) controlling for age and sex, chest pain was found to be a positive predictor of attendance in rehabilitation. Negative predictors were gross income below DKK 100 000, single living and T-wave inversion. The predictive validity of the model was 76.0%,

Table 1 Readmission for MI (Re-MI), percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) within 1 year of admission and mortality within 2 years of admission, by cardiac rehabilitation attendance among 200 consecutive patients with incident acute myocardial infarction, who survived the first 30 days of admission. Aarhus, Denmark, April 2000 to March 2002

	Patients		Median Age	Re-MI	PCI	CABG	1-year mortality	2-year mortality
Rehabilitation	No.	%[a]	Years	%[b]	%[b]	%[b]	%[b]	%[b]
Attendance	145	72.5	59.8	22.1	48.3	11.0	2.1	2.8
Non-attendance	55	27.5	59.7	10.9	25.5	5.5	14.5	21.8
P-value	–	–	$P = 0.93$	$P = 0.07$	$P = 0.004$	$P = 0.23$	$P = 0.001$	$P = 0.0001$

a: Percent of total.
b: Percent of attendance group.

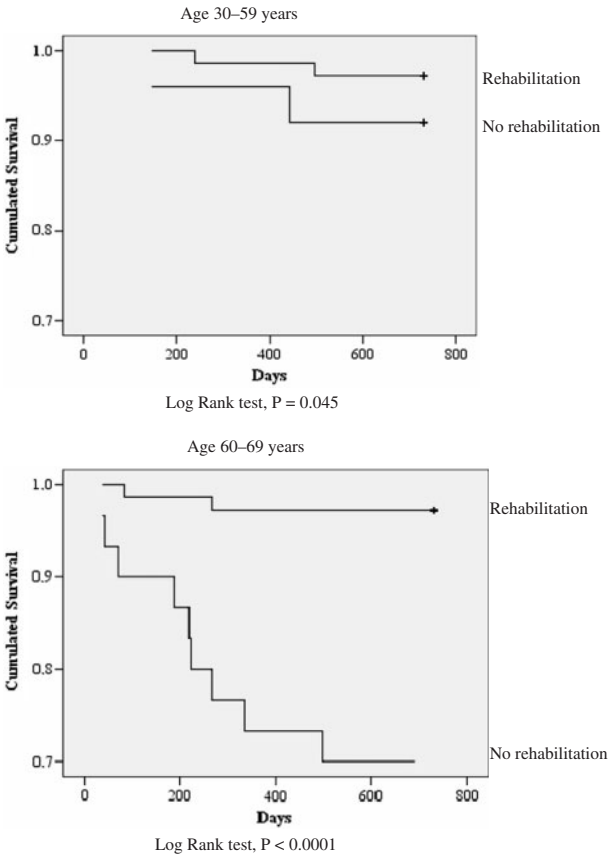

Figure 1 Kaplan–Meier Survival plots comparing patients attending cardiac rehabilitation (CR) with patients not attending CR, stratified by age, among 200 consecutive patients with incident myocardial infarction, who survived at least 30 days of admission. Aarhus, Denmark, April 2000 to March 2002

as indicated by the area under the Receiver Operating Characteristics (ROC) curve.

In the older age group (60–69 years) the benefit of attending CR is more pronounced than among younger patients (figure 1).

Discussion

In the present observational study, we found a lower mortality rate among patients attending CR. This is also well documented in randomised trials.[24] The lower mortality rate among CR attendees in the present study is partly attributed to a selection of healthy patients.

This study is limited by the relatively small number of MI patients and by the exclusion of patients above age 70. The problem with co-morbidity was the main reason for us to exclude older patients. Although our study results are context dependent, we believe that they show a realistic picture of the every day clinical setting for MI patients, since all patients from a well-defined cohort were included during two years. We were able to combine data from Danish registers as it concerns socioeconomic factors with clinical data obtained from patient charts, and thus we had complete study participation.

We found that three out of four MI patients attended CR. Patients without chest pain (atypical symptoms) are known to have a poor prognosis.[10,25,26] In this study chest pain was independently associated with CR attendance, although the 95% confidence limits were wide (table 3), a problem probably caused by the small number of patients. Chest pain is the strongest subjective warning sign and it also functions as such for the physician. Patients with MI, who present without chest pain, may be treated with a delay and with a smaller fraction to be referred for invasive treatment.[7,27] Moreover, diabetic patients with atypical symptoms have a poor outcome[28] as have patients with pulmonary oedema and arrhythmia, which are known to be associated with atypical symptoms.[25,29]

Table 2 Attendance in cardiac rehabilitation by sex, social parameters, symptoms, and clinical parameters, within 7 days of admission, in 200 consecutive patients with incident acute myocardial infarction. Aarhus, Denmark, April 2000 to March 2002

	Patients		Cardiac rehabilitation attendance			
Background	**No.**	**%[a]**	**No.**	**%[b]**	**OR[c]**	**95% CI[d]**
Sex—Male	151	75.5	108	71.5	0.8	0.4–1.3
Citizenship—Foreign	8	4.0	3	37.5	0.2*	0.1–0.4
Family type—Single adult	48	24.0	28	58.3	0.4*	0.2–0.7
Job title						
Active employment	115	57.5	77	67.0	0.4*	0.2–0.8
Employees—upper level[e]	13	6.5	12	92.3	4.8*	3.1–7.0
Economy—Gross income < DKK 100 000	27	13.5	12	44.4	0.2**	0.1–0.3
Symptom—Chest pain	179	89.5	138	77.1	6.7***	5.0–8.9
ECG						
ST–elevation	102	51.0	74	72.5	1.0	0.6–2.5
ST-depression	91	45.5	66	72.5	1.0	0.5–3.0
T-wave inversion	104	52.0	68	65.4	0.5*	0.2–0.8
Tachycardia—≥ 100/min	30	15.0	16	53.3	0.4*	0.1–0.9
Fasting Glucose—≥ 6.1 mmol/l	96	48.0	69	71.9	1.0	0.5–1.9
LDL cholesterol—≥ 3.0 mmol/l	96	48.0	76	79.2	1.9*	1.2–3.1
Treatments						
PCI[f] within 7 days	54	27.0	44	81.5	2.0	1.1–4.0
Aspirin	180	90.0	136	75.6	3.7**	2.1–5.1
Beta-blocker	162	81.0	123	75.9	2.3*	1.9–4.4

a: Percent of total.
b: Percent of group participating in cardiac rehabilitation.
c: OR: Odds ratio controlled for age. Persons without the characteristic constitute the reference group.
d: CI: Confidence intervals.
e: Employees upper level (of three levels) including architect, doctor, mid-wife, journalist, musician, lawyer and priest.
f: PCI: Percutaneous coronary intervention.
Only significant social parameters are shown.
*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

Table 3 Predictors[a] of attendance in cardiac rehabilitation by social and clinical parameters at admission in 200 consecutive incident patients with acute myocardial infarction. Aarhus, Denmark, April 2000 to March 2002

	Attendance in rehabilitation	
Predictor	**OR**	**95% CI**
Family Type—Single adult	0.4*	0.2–0.9
Economy—Gross income < DKK 100,000	0.2***	0.1–0.5
Symptom—Chest pain	8.6***	3.0–24.8
ECG[b]—T-wave inversion	0.4*	0.2–0.9

a: Based on multiple logistic regression. Model fit: $P = 0.7$. The shown coefficients have been controlled for age and sex.
b: ECG: Electrocardiogram at admission.
*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

In the present study, 90% of patients with MI had chest pain at admission, and thus the standards of MI treatments and hospital routines focus on such patients. A higher level of awareness is needed among the treatment providers to refer patients with atypical symptoms for CR or invasive treatments.

CR-non-attendance was associated with low gross income, single living and with T-wave inversion in the ECG. Socioeconomic and psychological factors, such as lack of social support, are well known to influence the prognosis after MI.[6,30] Single living may be associated with lack of social support and with social habits like eating, drinking and smoking. Too little attention seems to be given to patients with lack of social resources, in spite of the fact that coping problems are well known in such patients.

The coronary care unit at Aarhus Sygehus has a well-established routine in referring MI patients for CR leading to attendance in three out of four MI patients. Patients are presented to CR in the acute phase of the MI and as a result the motivation to attend rehabilitation may be stronger than in most other studies.[4] Another explanation of the high attendance rate in this study is the age limit excluding patients above age 70. Females and patients at high age were not less likely to attend CR, as has been found by other authors.[4,5] The benefit of attending CR was more pronounced among older patients (60–69 years) (figure 1). Co-morbidity and a selection of healthy patients is a part of the explanation, but more effort should be given to these patients to modify their risk factor profile and make them attend CR in order to reduce their mortality risk. The problem is probably more apparent in patients above age 70 who are often excluded from studies.

The attendance proportion among patients with foreign citizenship (37.5%) was not as high as among Danish patients (72.5%), although not significantly associated with non-attendance in the multivariate test.

In all CR programmes, even those with relatively high attendance, more attention should be given to encourage older patients, those with foreign citizenship, those living alone and patients of low socioeconomic status to attend. Motivation could be sustained by hospital staff, during the initial hospital stay, and by the general practitioner. Such attempts to motivate socially vulnerable patients seem to be successful in improving CR attendance rate as preliminary data from our own interventional studies suggest.[31]

Conclusion

One-fourth of MI patients do not attend the comprehensive CR programme. Non-attendees have a higher mortality risk, which in part may be attributed to selection of healthy patients. Non-attendees are older and more likely to have atypical symptoms at admission, a low socioeconomic status and to live alone. Special attention is needed to improve cardiac rehabilitation attendance among such patients.

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Conflicts of interest: None declared.

Key points

What this paper adds:

- Patients with atypical symptoms, high age, those living alone or having a low gross income have a poor prognosis and are less likely to attend cardiac rehabilitation.
- Even among attendees in a comprehensive cardiac rehabilitation programme, the treatment targets are difficult to achieve.

Implication for public health policy and practice:

- Attendance for cardiac rehabilitation is likely to be improved if older or socially vulnerable patients are offered extended rehabilitation programmes.
- Survival after first myocardial infarction may be improved, especially in older or socially vulnerable patients, if attendance rate for cardiac rehabilitation is increased.
- Two out of three patients with first myocardial infarction show signs of the metabolic syndrome and should be dealt with carefully.

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